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Salmonella on U.S. Swine Sites—Prevalence and Antimicrobial Susceptibility

Background

In 2006, there were 17,252 cases of laboratory-diagnosed foodborne illnesses attributed to 10 organisms under surveillance by the Centers for Disease Control and Prevention (CDC). *Salmonella* was the most common bacterial pathogen identified, accounting for 38.6 percent of the cases.¹ In humans, *Salmonella* causes fever, abdominal cramping, and diarrhea. Severe cases can result in systemic infections and even death. In a CDC analysis of the impact of foodborne illnesses, nontyphoidal *Salmonella* accounted for 25.6 percent of hospitalizations and 30.6 percent of deaths due to known foodborne pathogens.²

Foodborne *Salmonella* infections have been attributed to raw, undercooked, or contaminated poultry and poultry products; eggs, meat, and meat products; dairy products; vegetables; and other agriculture sources.³

Salmonella organisms can be transmitted from pigs to humans through consumption of contaminated pork products and direct contact with infected animals.^{4,5}

Pigs can shed *Salmonella* in their feces during all stages of pork production without showing any clinical symptoms. Shedding is also common during transportation and at lairage (holding pens) in slaughter houses. Clinical signs of salmonellosis in pigs include fever, diarrhea, anorexia, abortion, and decreased weight gain.⁶

Although over 2,500 serotypes of *Salmonella* have been identified, most laboratory-confirmed *Salmonella* infections in pigs are due to a small number of serotypes. Antimicrobial resistance is serotype dependent. Multidrug-resistant strains of *Salmonella*, such as *S. Typhimurium*, have been recognized for years as important swine and human pathogens and are of concern to both veterinary and public health officials.

Salmonella on U.S. swine sites

In 2006, the USDA's National Animal Health Monitoring System (NAHMS) conducted a study on swine health and management practices from a random sample of swine production sites with 100 or more pigs in 17 States.* These States represented approximately 94 percent of U.S. pig inventory and 94 percent of U.S. pork producers with 100 or more pigs.

As part of Swine 2006, fecal samples were collected from different areas of pen floors on 135 sites. On each site, up to 60 fecal samples were collected from pens containing grower/finisher pigs and cultured for *Salmonella*. From September 5, 2006, through March 15, 2007, 7,788 samples were cultured for *Salmonella*.

Overall, at least one sample was found culture-positive for *Salmonella* on 52.6 percent of sites, 43.5 percent of barns, and 18.4 percent of pens. Of the fecal samples cultured, 564 (7.2 percent) were positive for *Salmonella*. From these samples, 584 isolates were recovered (20 samples had 2 isolates). Twenty-seven different serotypes were identified; however, 4 serotypes accounted for 70.5 percent of isolates (table 1).

Table 1. Number and Percentage of Isolates and Number and Percentage of Sites by *Salmonella* Serotypes Isolated, 2006

<i>Salmonella</i> Serotype	Number Isolates	Percent Isolates	Number Sites	Percent Sites
Derby	173	29.6	31	23.0
Typhimurium (Copenhagen)	132	22.6	21	15.6
Agona	63	10.8	13	9.6
Anatum	44	7.5	7	5.2
All others	172	29.5	63	46.6
Total	584	100.0	NA	NA

* States

Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, and Wisconsin.

The 584 *Salmonella* isolates were tested for resistance to a panel of 15 antimicrobial drugs.** Resistance break points used by the National Antimicrobial Resistance Monitoring System were used to classify isolates as susceptible, intermediate, or resistant.

The percentage of *Salmonella*-positive sites was higher in Swine 2006 (52.6 percent) than in the NAHMS Swine 1995 and Swine 2000 studies (38.2 and 32.8 percent of sites, respectively). A comparison of the ranking of frequently isolated serotypes in 1995, 2000, and 2006 is shown in table 2. Derby, Agona, and Typhimurium Copenhagen were the top three serotypes in all three studies.

Table 2. Ranking of Most Common *Salmonella* Serotypes Identified from Three NAHMS Studies

Rank	1995	2000	2006
1	Derby	Derby	Derby
2	Agona	Agona	Typhimurium Copenhagen
3	Typhimurium Copenhagen	Typhimurium Copenhagen	Agona
4	Brandenberg	Heidelberg/Brandenberg	Anatum
5	Mbandaka/Typhimurium (tie)	(tie)	Meleagridis/Typhimurium (tie)
6	(tie)	Anatum	(tie)
7	Heidelberg/Anatum (tie)	Typhimurium/Worthington (tie)	Worthington
8	(tie)	(tie)	Barranquilla/Johannesburg (tie)
9	Enteriditis	Infantis	(tie)
10	Worthington	Uganda	Muenchen

Antimicrobial susceptibility

Table 3 shows that all isolates were susceptible to amikacin, ceftriaxone, ciprofloxacin, and naladixic acid. Resistance to tetracycline was most common (78.6 percent of *Salmonella* isolates), followed by resistance to sulfisoxazole (67.3 percent of isolates).

Table 3. Number and Percentage of *Salmonella* Isolates Resistant* to the Following Antimicrobials

Antimicrobial	Number	Percent
Tetracycline	459	78.6
Sulfisoxazole	393	67.3
Streptomycin	311	53.3
Ampicillin	226	38.7
Chloramphenicol	194	33.2
Amoxicillin/clavulanic acid	88	15.1
Cefoxitin	88	15.1
Ceftiofur	85	14.6
Kanamycin	59	10.1
Trimethoprim/sulfamethoxazole	44	7.5
Gentamicin	12	2.1
Naladixic acid	0	0.0
Ciprofloxacin	0	0.0
Ceftriaxone	0	0.0
Amikacin	0	0.0

* Intermediate isolates were classified as not resistant.

Table 4 shows the multi-drug resistance of the 584 isolates tested. About 20 percent of *Salmonella* isolates were susceptible to all antimicrobial drugs tested. Overall, 79.6 percent of the isolates were resistant to at least one antimicrobial drug, 73.9 percent were resistant to more than one antimicrobial drug, and 8.7 percent were resistant to nine or more drugs.

Table 4. Number of Antimicrobials by Number and Percentage of *Salmonella* Isolates Showing Resistance*

Number Antimicrobials	Number <i>Salmonella</i> Isolates	Percent <i>Salmonella</i> Isolates
0	119	20.4
1	33	5.6
2	95	16.3
3	116	19.9
4	42	7.2
5	92	15.7
6	8	1.4
7	14	2.4
8	14	2.4
9 or more	51	8.7
Total	584	100.0

* Intermediate isolates were classified as not resistant.

** Amikacin, amoxicillin/clavulanic acid, ampicillin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, naladixic acid, streptomycin, sulfisoxazole, tetracycline, and trimethoprim/sulfamethoxazole.

Conclusions

Although the prevalence of *Salmonella* in swine feces in the United States remains low (7.2 percent of fecal samples tested culture positive), 52.6 percent of sites had one or more positive fecal cultures. The top three *Salmonella* serotypes isolated from swine feces have remained the same since 1995. Overall, 85.1 percent of isolates were resistant to 5 or fewer antimicrobials. Over 20 percent were not resistant to any 15 antimicrobials evaluated.

References

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